Attorney's Docket No.: 08935-0299001/ M-5033

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants :	Javit A. Drake et al.	Art Unit :	1795
Serial No. :	10/664,405	Examiner :	Hodge, Robert W.
Filed :	September 16, 2003	Conf. No. :	3194
Title :			

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

DECLARATION UNDER 37 C.F.R. § 1.131

I, Javit A. Drake declare as follows:

1. Andrew G. Gilicinski, Gordon G. Guay, Leslie J. Pinnell and I are co-inventors of the subject matter claimed in the application identified above ("the present application").

2. The subject matter claimed in the present application is entitled to a filing date of September 16, 2003.

3. At the time we made the invention claimed in the present application we were all employed by The Gillette Company. The subject matter of the present application was disclosed internally to The Gillette Company after its initial conception. The date of the initial conception was prior to July 29, 2003.

4. As evidence of our conception, we attach hereto a copy of an invention disclosure (attached as Exhibit A) made to the assignee, The Gillette Company. The conception date as well as some other parts of the disclosure have been redacted. However, the conception date is prior to July 29, 2003.

5. As shown in the figures and accompanying description in Exhibit A, the disclosed technology fuel cell containers and cartridges including localized heated vaporization (page 5) and enhanced membranes for vaporization of liquid fuel (pages 3-5). Also included in the

CERTIFICATE OF MAILING BY EFS-WEB FILING

I hereby certify that this paper was filed with the Patent and Trademark Office using the EFS-WEB system on this date: January 16, 2009

invention disclosure (pages 6 and 7) are embodiments of a fuel cartridge system that includes at least a housing, a fuel egress port, a bladder, a piston urged against the bladder and a spring that urges the piston against the bladder.

6. We constructively reduced to practice the invention covered by the subject matter of the claims of the present application by filing the present patent application on September 16, 2003 with diligence at least prior to July 29, 2008 to the filing date of the present application.

I declare further that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further, that the statements were made with knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date: January 9, 2009

Javit A. Drake
Javit A. Drake

Exhibit A

(m-5031)

Invention Disclosure Statement No. N/A
Assigned by Pat. Dept.

The Gillette Company [redacted]

INVENTION DISCLOSURE SUBMISSION

This form should be used to advise the Patent Dept. of a potentially patentable invention where some work or experimentation has been completed and initial results show sufficient promise to warrant a determination of patentability. This form should not be used to report untested concepts or research proposals (unless testing is not required to prove the concept). This form must be signed by your Manager or Director.

1. Short title:

Enhanced Fuel Delivery for Direct Methanol Fuel Cells

Submitted by: **Javit A. Drake, Andrew G. Gilicinski and Leslie Pinnell**

Javit A. Drake [redacted]
Signature of 1st Submitter / Date

Andrew G. Gilicinski [redacted]
Signature of 2nd Submitter / Date

Leslie J. Pinnell [redacted]
Signature of 3rd Submitter / Date

Signature of 4th Submitter / Date

2. Description of the invention (attach extra sheets as needed):

(a) Background. Describe what has been done prior to the present invention and any shortcomings, problems or disadvantages associated therewith.

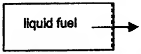
[redacted]

Exhibit A

[redacted]

Object of the invention. Describe the problem it solves and any advantages it has over previously known methods, compositions or apparatus.

The object of the invention is to enhance the rate of vapor feed fuel delivery to fuel cells via engineered approaches residing within a fuel reservoir or fuel cartridge which is connected to the DMFC. The invention provides advances over simple vapor feed to a fuel cell using the straightforward application of a planar vaporization membrane.



fuel reservoir or cartridge

The rate of fuel delivery is proportional to the geometric area of the planar membrane. As such, the use of planar membrane vaporization is limited to low power (e.g., <3 W) fuel cell applications. This invention proposes novel methods to augment the rate of fuel delivery by making it practical to create compact fuel reservoir or fuel cartridge systems to provide vapor phase methanol fuel to higher power DMFC systems.

(b) Describe the invention in detail, including any examples, experiments, prototypes, etc. which have been completed and any data and test results. Drawings, sketches, composition or formulation details should be included as appropriate. All materials employed and process parameters utilized should be specified as completely as possible, such as preferred pH ranges, temperatures, molar ratios, etc. Include preferred ranges, such as "150° C ± 5%".

Different methods of enhancing and stabilizing the rate of fuel delivery are proposed. The methods apply to the fuel cell assembly, a permanently attached fuel reservoir, or replaceable fuel cell cartridge.

1. High surface area membranes

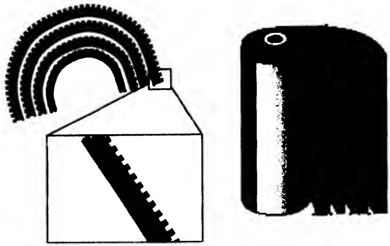
This strategy entails 1) the utilization of a greater perimeter of a fuel containing reservoir or cartridge 2) multiple layers or folds of membrane to increase permeation surface area or 3) a macroscopically or microscopically roughened membrane to increase effective membrane surface area for pervaporation. Option 1 is illustrated schematically below:

fuel reservoir or cartridge

The dashed line indicates a gas permeable membrane. Rather than use the membrane in planar geometry at the outlet, the membrane is chosen to surround the fuel volume enabling increased membrane area and thus delivery rate for a given cartridge or reservoir size. Vapor occupies the interstitial volume between the membrane and reservoir.

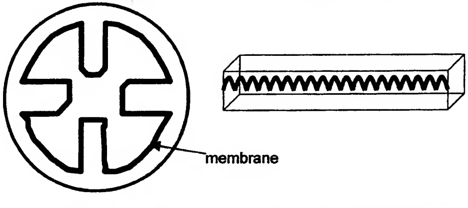
Using layers or folds of membrane (option 2) also increases membrane area. A multilayer example is the wound-cell format, shown below:

Exhibit A



In this approach, a pervaporation membrane is placed over a porous "sponge" material that holds methanol within it and enables liquid methanol to migrate to the membrane as it vaporizes. The back of the sponge is coated with a methanol-impermeable layer. This 3 layer system can be envisioned being wound and placed into a cylindrical container, with an array of gaps between the pervaporation membrane and the methanol-impermeable layer providing a route for transporting a high flux of methanol vapor to the anode chamber in the fuel cell. This method provides the possibility of very high flux in a very compact fuel reservoir or fuel cartridge geometry. The wound cell differs from U.S. Patent 6,506,513 B1 by Toshiba in that here, the vaporization high membrane area is used and integrated with the wicking material ***within*** the fuel cartridge.

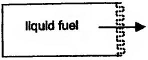
Various intermediate designs between the high surface area of wound-cell format and the rectangular, liquid-fuel-surrounding membrane (option 1) exist:



The intermediately dense folded layouts can balance the high fluxes obtainable in the multilayer configuration and the low membrane volume (i.e., high fuel energy density) of option 1.

Exhibit A

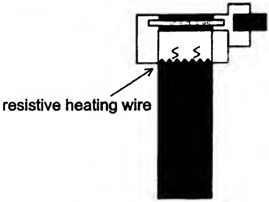
Another approach to rate enhancement through membrane layout is through random or patterned roughening (option 3), and is illustrated below:



The result is an augmentation of the effective surface area of the membrane (and thus an overall rate of permeation) while maintaining a constant geometric area.

2. Localized heated vaporization of liquid fuel

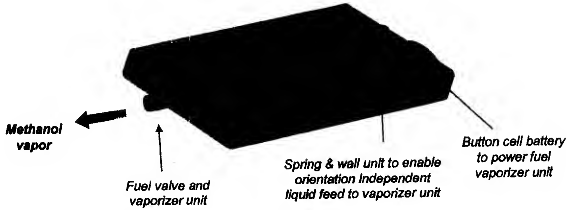
A second fundamental approach is localized heating to vaporize a liquid fuel. As one example, a resistive heating element can be applied at a membrane interface to enhance vapor fuel delivery as illustrated below:



In a pervaporation process, the rate of vaporization increases significantly with temperature. The resistive element, illustrated here in parallel with the primary load, can use a fraction of the fuel cell electrical output and provide a net boost in output power.

Another potential option is to dispense with a pervaporation membrane entirely and vaporize methanol entirely through a thermal process. In this situation, it may be desirable to draw power for the vaporization from the fuel cell, or it may be more convenient to supply this power through a small battery (button cell, for example) located within the fuel cartridge itself for the case of a replaceable fuel cartridge. An example is illustrated below:

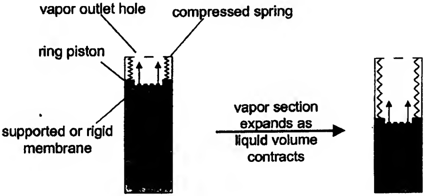
Exhibit A



In this figure, the fuel valve is envisioned to be integrated with a vaporization unit consisting of resistive heating elements in a constricted area within a valve assembly. Power for the resistive heaters can be obtained by a button cell battery within the fuel cartridge, or from the fuel cell power source via external leads (not shown). An internal fuel bladder (not shown) is envisioned to be pushed by a wall and spring unit that enables liquid fuel delivery to the valve and vaporizer unit regardless of cartridge orientation. Beyond this described system, many variations on this approach can be envisioned.

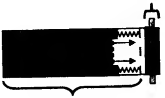
3. Vacuum vaporization of liquid fuel

A third fundamental option to enhance vapor delivery is to create a slight vacuum on the permeate (vapor) side of a pervaporation membrane and using the principle that pressure decrease (similar to a temperature increase) can boil or evaporate a liquid. Stated differently, a slight vacuum downstream incrementally decreases the vapor concentration of fuel, thereby increasing the driving force for permeation from the liquid phase. A possible mechanism to induce a slight vacuum is to increase volume on the vapor side. A cartridge device employing this mechanism is depicted here:

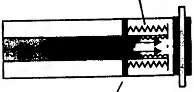


As the liquid volume depletes, the vapor side increases in volume. Again, the pervaporation membrane contains the liquid and allows only vapor to permeate. The mechanical action can be

active (e.g. with the force of springs) or passive (e.g., with liquid displacement alone). Passive actuation relies on low friction of the ring piston. In the figure below, connection to a fuel cell stack (consisting of a single membrane electrode assembly, in this case) illustrates the confined but increasing volume of the vapor side.



Furthermore, the volume of expansion induced in the vapor section can be made greater than the contraction volume of the liquid fuel phase. That is, additional expansion of the vapor phase cavity may be employed:



The expansion may be independent of liquid depletion as shown here with independent springs. Alternatively, the outer ring piston may be connected mechanically (or magnetically if desired) to slide in parallel with the inner piston movement with liquid depletion. Furthermore, the vapor side cavity may be shaped (e.g., cone-like) to allow for an increasing volume expansion as the fuel depletes. Vapor-side expansions greater than the liquid contraction do have the disadvantage of requiring additional overall volume.

(c) Describe any modifications to the invention or alternative embodiments (even if untested) which you believe might provide similar results. Include in this section lists of alternative materials and also preferred ranges or parameters which can be employed (e.g. 10-30% of component X and 20-50% of component Y, 400-700 rpm, 50-95°C, polyhydric alcohol with 2-6 carbon atoms and 2-6 hydroxyl groups, viscosity of 10-200 cp.)

A number of configurations to this invention are envisioned and are listed in (but not limited to) examples in the prior section.

In addition, the invention applies to alternative fuels and combinations or formulations of fuels. Ethylene glycol, formic acid, and water are all volatile liquids that have been proposed or demonstrated as fuels in fuel cells.

Also, the dilute phase into which the liquid fuel permeates need not be vapor. Delivery into a liquid or solid phase is possible for the heated vaporization and high surface area arrangements to enhance delivery rate. Instead of vacuum enhancement of vaporization, a liquid permeate phase is possible. The expansion can draw in recycled water from the cathode side of a fuel cell, for instance.

For control of fuel delivery, the membrane may be synthesized or processed (by localized compression or elongation, for example) to have variable permeability with surface position. For instance, if a non-uniform distribution of fuel to the anode exists, a position-variable permeability (and thus variable fuel flux) can be designed to even the distribution.

(d) Describe the best way to practice the invention currently known to you. That is, identify those materials or parameters which provide, or you think will provide optimum results.

The preferred approach to fuel delivery enhancement depends upon the application (output power needed, volume available, operating temperature). For the membrane, a high flux pervaporation material with high selectivity for the liquid fuel is ideal.

3. Prior art. Identify any publications (inc. journals, sales brochures and patents) and any Duracell or competitive products which may be relevant to this invention, may aid in understanding this invention, or may describe other attempts to achieve a similar purpose. List any relevant patents or publications and include full copies of them with this form.

[redacted]

Exhibit A

[redacted]

Enhancements to the vaporization process for fuel delivery does not appear to exist in the prior art.

4. Attach copies of laboratory notebook pages, research reports, or memoranda, which describe experiments or tests relating to the invention. Identify the earliest notebook entry pertaining to the invention, below:

(a) Conception date: [redacted]________________ Notebook: 2785____________________

(b) First test date: Lab testing started in [redacted] Notebook:________________________

(c) First drawings (date/no.): [redacted] (for this IDS)________________________________

(d) First disclosure within Duracell: Discussions between A. Gilicinski and Leslie Pinnell and between J. Drake and A. Gilicinski, [redacted]

5. Indicate below the approximate date or dates on which the invention has been or will be exposed to outsiders (e.g. test panelists, vendors, suppliers, key accounts, etc.) and provide details of the circumstances. Please indicate if the recipients were bound to confidentiality. Also, indicate the expected date further laboratory tests will be available, or the date of commercial implementation. **Note well: A single non-confidential disclosure prior to filing a patent application could bar foreign patent protection or U.S. Patent Protection.**

(a) First disclosure outside Duracell, such as to outside vendor(s): None______________

(b) Company name of outside vendor(s): ______None____________________________

(c) Was a Confidentiality Agreement in place with these vendor(s) prior to disclosure? N.A.

Exhibit A

(d) Other disclosures: None

(e) Expected date of first consumer test: Unknown

(f) Expected date of commercialization: Unknown

(g) Expected date sales samples will be shown to outsiders: Unknown

(h) Expected date of any Technical Journal Publication: None

(i) Expected date of any Technical Conference Presentation: None

(j) Further laboratory test results will be available: [redacted]

[redacted]

6. List all persons involved in the conception or development of the invention and briefly indicate the nature of the contribution (e.g. "Bob T - suggested inclusion of gummy bears in lube strip; Ann B - determined green ones work best.").

[redacted]

Note: The Patent Dept. will determine inventorship based upon the patent claims which are filed and an inquiry into the contributions of each person involved. This determination is based on legal requirements and does not reflect on the importance of any contribution. Indeed, it is possible to perform extensive work and yet not be an inventor.

Read and Understood By: Leslie J. Pirnell Date: [redacted]
(Manager or Director)

Read and Understood By: Kivakodu Nanjundaswamy Date: [redacted]
(Another person, not an inventor to this disclosure)

Exhibit A

7. <u>ADDITIONAL INFORMATION</u> (*If you include additional information on this page, this page must also be signed below. Discard this page if it is not needed. Attach additional copies of this page if needed, with original, not copied, signatures at the bottom of each page.)

[redacted]

Read and Understood By: Leslie J. Pirnell Date: [redacted]
(Manager or Director)

Read and Understood By: Kirakodu Nanjundaswamy Date: [redacted]
(Another person, not an inventor to this disclosure)

Exhibit A

[redacted]